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	Patents ADP number *(if you know it)*	7769773001
	If the applicant is a corporate body, give the country/state of its incorporation	England
4.	Title of the invention	Improvements in or relating to Drive Systems
5.	Name of your agent *(if you have one)*	~~Ipca Consulting Limited~~ Urquhart-Dykes & Lord LLP (51/77 - 17.12.04)
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IMPROVEMENTS IN OR RELATING TO DRIVE SYSTEMS

Field of the Invention

This invention relates to drive systems. The system described herein has been developed for particular application to hydraulically powered elevators, lifts or lifting platforms but it will be appreciated that a drive system as disclosed herein could have application in a variety of alternative fields.

In the following specification the terms ‘elevator’, ‘lift’ and lifting platform are used inter-changeably and are intended to have the same meanings.

Background to the Invention

In typical hydraulic powered elevators or lifts, the combination of the weight of the moving equipment or lift car, and the load carried thereby, is lifted by the effect of fluid displaced by a hydraulic pump unit. The operation of the hydraulic pump generates considerable heat which, in the confined space of a lift well or lift machine room, can be difficult to dissipate. In any event, the heat represents lost energy and less than optimum efficiency.

Various attempts have been made, in the past, to reduce the power requirement, and thus the heat generation.

One method adopted in the past, is the use of a mechanical counterweight. The disadvantage of a mechanical counterweight is that it requires its own set of vertical guide rails. This adds both to material costs and installation times.

More recently, hydraulic lift installations have been provided with one or more hydraulic accumulators into which hydraulic fluid is displaced as the lift car moves downwards. Typically, within the accumulator is a membrane which separates the

incoming fluid from a chamber of compressed gas. The incoming fluid further compresses the gas. When the lift car is called to rise and the fluid within the accumulator is released, the gas within the accumulator helps expel the oil and thus displace the lift car upwardly. Examples of lift accumulators can be found in International Patent Application Nos. WO 99/33740 and WO 01/14238.

Whilst accumulators do assist in reducing the power requirement to raise the lift car and load, the working fluid is still subject to the total weight of the lift car and load. Further, there is added cost in providing the accumulator and associated pipe work and instances have been reported of accumulators causing the lift car to rise unintentionally when there has been a failure of one or more of the control valves.

It is an object of this invention to provide a method of, and means for reducing the power requirement of a hydraulic lift which will go at least some way in addressing the problems expressed above; or which will at least provide a novel and useful choice.

Summary of the Invention

Accordingly, in a first aspect, the invention provides a method of reducing the power requirement of a lift having a load carrier and an hydraulic drive system, including hydraulic fluid, to displace said lift car toward and away from a base,
said method comprising positioning support means between said base and said load carrier, said support means being configured not to receive said hydraulic fluid and being positioned and operable to at least partly support said load carrier.

In a second aspect, the invention provides a method of reducing the power requirement of a lift having a load carrier and an hydraulic drive system to displace

said load carrier toward and away from a base,
said method comprising positioning at least one gas strut so as to operate with the displacement of said lift car, said gas strut being constructed and arranged to at least partly support said load carrier.

In a third aspect, the invention provides a method of reducing the power requirement of a lift having a load carrier and an hydraulic drive system to displace said load carrier toward and away from a base,
said method comprising positioning at least one spring accumulator so as to operate with the displacement of said load carrier, said spring accumulator being constructed and arranged to at least partly support said load carrier.

Preferably method comprises positioning said gas strut or said spring accumulator between said load carrier and said base.

Preferably each of said hydraulic drive system, said gas strut and said spring accumulator has an operating stroke, said method comprising positioning said gas strut or said spring accumulator so that the stroke thereof is substantially parallel to the stroke of said hydraulic drive unit.

Preferably said method comprises constructing and arranging said gas strut or spring accumulator so that the stroke thereof is co-linear with the stroke of said hydraulic drive unit.

In a fourth aspect, the invention provides a lift having a load carrier and an hydraulic drive system, including hydraulic fluid, to displace said load carrier toward and away from a base,
said lift being characterised in that support means are positioned between said base and said lift car, said support means being configured not to receive said hydraulic fluid and being operable to at least partly support said load carrier.

In a fifth aspect, the invention provides a lift having a load carrier and an hydraulic drive system to displace said load carrier toward and away from a base,
said lift being characterised in that at least one gas strut is provided so as to operate with the displacement of said lift car, said gas strut being constructed and arranged to at least partly support said load carrier.

In a sixth aspect, the invention provides a lift having a load carrier and an hydraulic drive system to displace said load carrier toward and away from a base,
said lift being characterised in that at least one spring accumulator is provided so as to operate with the displacement of said load carrier, said spring accumulator being constructed and arranged to at least partly support said load carrier.

Preferably said at least one gas strut or said at least one spring accumulator is positioned between said load carrier and said base.

Preferably each of said hydraulic drive system, said gas strut and said spring accumulator has an operating stroke, said gas strut or said spring accumulator being positioned so that the stroke thereof is substantially parallel to the stroke of said hydraulic drive unit.

Preferably the stroke of said gas strut or spring accumulator is co-linear with the stroke of said hydraulic drive unit.

In a seventh aspect the invention provides a lift having a load carrier characterised in that a stroke-based support device (as herein defined) is provided to at least partly support the weight of said load carrier.

In an eighth aspect the invention provides a lift having a load carrier and at least one hydraulic ram having a first operating axis, said ram being operable to displace said load carrier in upwards and downwards directions, said lift being characterised in that

it further includes a stroke-based support device (as herein defined) having a second operating axis, said stroke based support device being constructed and arranged to at least partly support the weight of said load carrier, wherein said second operating axis is substantially parallel to said first operating axis.

Preferably said second operating axis is substantially co-linear with said first operating axis.

In a ninth aspect the invention provides operating means for displacing a load in a linear direction, said operating means including a piston displaceable from and into a cylinder, along a substantially linear drive axis, by the entry and egress respectively of pressurised hydraulic fluid into and from said cylinder; and support means constructed and arranged to at least partly support the weight of a load which is applied to said piston and which load has a tendency to bias said piston into said cylinder.

Preferably said operating means includes a housing; said cylinder and support means being located within said housing.

Preferably said support means has an operating stroke in which a supporting force is applied along a substantially linear support axis, said support axis being substantially parallel to said drive axis.

Preferably said support means is arranged about said hydraulic cylinder wherein said support axis is substantially co-linear with said drive axis.

Preferably said support means includes a further chamber located about the exterior of said hydraulic cylinder; a pressurised gas within said further chamber; and a second piston displaceable with the aforementioned piston, said second piston being displaceable within said further chamber whilst said aforementioned piston is displaceable within said hydraulic cylinder.

Preferably said support means is further constructed and arranged to, in use, assist in driving said piston from said cylinder.

In a tenth aspect the invention provides a hydraulic or pneumatic drive ram having a cylinder; a piston rod extendible from, and retractable into, said cylinder; and a working fluid, said drive ram being characterized in that said piston rod has an interior chamber in communication with said cylinder, said chamber, in use, receiving said working fluid.

Many variations in the way the present invention can be performed will present themselves to those skilled in the art. The description which follows is intended as an illustration only of one means of performing the invention and the lack of description of variants or equivalents should not be regarded as limiting. Wherever possible, a description of a specific element should be deemed to include any and all equivalents thereof whether in existence now or in the future. The scope of the invention should be limited by the appended claims alone.

Brief Description of the Drawings

One operating embodiment of the invention will now be described with reference to the accompanying drawings in which:

Figure 1: shows an elevational view of a hydraulic lift to which the various aspects of the invention may be applied;

Figure 2: shows a diagrammatic view of a prior art accumulator system for reducing the power requirement of a hydraulic lift;

Figure 3: shows a diagrammatic view of a lift with reduced power requirement embodying the broad principles of the invention;

Figure 4: shows a cross-sectional view of operating means according to the invention in a fully retracted state; and

Figure 5: shows a view similar to Figure 4 but with the operating means in a partially extended state.

Detailed Description of Working Embodiment

Referring firstly to Figure 1, a typical hydraulic lift installation comprises a load carrier in the form of lift car or platform 10 supported on lift guides 12, the guides 12 being fixed to, and extending vertically upwards, in a lift shaft 14. A hydraulic ram 16, having a moving piston 17, is mounted on the base 20 of the lift shaft, the piston 17 engaging the underside of the lift car 10 so as to displace the lift car upwards and downwards in the lift shaft 14.

In order to extend piston 17 from the cylinder of ram 16, hydraulic fluid is pumped by motor/pump unit 22 drawing fluid from reservoir 24. When the lift car is required to move in the downwards direction, dump valve 26 is opened to allow the hydraulic fluid to pass directly back into the reservoir 24. Alternatively, the motor/pump unit is reversed to scavenge fluid from the cylinder and return the same to the reservoir 24.

In the particular embodiment shown in Figure 1, the piston 17 bears directly against the lift car 10 however, as is well known in the art, the piston may displace a roping arrangement which results in the displacement of the lift car 10 with respect to the displacement of the piston 17, being multiplied. Whilst such roping *per se* does not form part of this invention it can be used to advantage to increase system pressure and, thereby, allow the use of lower fluid volumes.

Indeed all that has been described above is entirely conventional as are variations thereof. For example, it is common to immerse the motor pump unit 22 within the fluid contained in reservoir 24.

In the past various means have been implemented to reduce the load on the hydraulic system and, thereby, reduce the overall power requirement. The most conventional means comprises a simple mechanical counterweight mounted so as to apply a displacement force to the lift car in a direction opposite to that applied to the lift car by the piston 17. As described above, a mechanical counterweight requires its own guide rails and roping arrangement and is thus relatively expensive to implement. It can also occupy significant space in the lift shaft. Thus, attention has been diverted to the hydraulic drive system itself in the search for a more efficient overall drive system.

Referring now to Figure 2, one known system for harnessing energy in a hydraulic lift installation involves the use of an hydraulic accumulator. In the manner described above, piston 17 is displaced to raise the lift car (not shown) by operation of hydraulic motor/pump 22. When the lift car is to descend, instead of the fluid in ram 16 being pumped or dumped back into the reservoir 24 as described above, it is pumped into the lower chamber 31 of an accumulator 30. The accumulator 30 also includes an upper, gas-filled chamber 32, the chambers 31 and 32 being separated by a moveable or flexible membrane 33.

When the lift car is next required to rise, a demand is placed on the fluid in chamber 31 of the accumulator, whereupon the compressed gas in chamber 32 expands and drives the fluid from chamber 31. It will be appreciated that this action positively assists the pump motor/pump unit 22.

Turning now to Figure 3, the drive element principles of a lift drive system according to the invention are entirely conventional and, as illustrated, include a hydraulic ram

16 having a piston 17 extendible there-from and retractable therein. Hydraulic fluid from reservoir 24 is, in the conventional manner, pumped by motor/pump 22 into the cylinder 16 to raise lift car 10. When the lift car is to descend, the motor/pump is reversed, or suitable valving (not shown) is operated, to cause the fluid in cylinder 16 to return to the reservoir 24.

The novelty in the present invention resides in providing one or more devices 30 which at least partially support the downward load imposed by the lift car 10. Whilst device 30 may be in close physical proximity to hydraulic drive components, it operates entirely independently of the drive system. The device 30 is preferably a stroke-based support device. That is to say, a device which operates along a substantially linear axis and generates a supporting function in at least one direction of movement. Typical examples of stroke-based resistance devices include gas struts and mechanical compression springs.

As can be seen, the support device 30 is preferably positioned so that the operating axis thereof is substantially parallel to the operating axis of the hydraulic drive. In effect the support device comprises a form of counterweight and, as such, reduces the load imposed on the hydraulic drive system by the lift car 10.

Turning now to Figures 4 and 5, the support device may be provided in unit with the hydraulic drive system. In such an arrangement, it is most convenient to apply the supporting or reactive force along the same axis as the drive force.

In the form shown, drive unit 31 comprises an outer cylinder body 32 which is fixed to base member 34. Fixed to the inner surface of base 34 is a static drive cylinder 36, the drive cylinder 36 being located centrally within outer body 32. Located over the drive cylinder 36, and in sliding contact therewith, is a piston cylinder 38, the upper end of which is capped by a piston 40. Mounting flange 42, by means of which the drive unit is attached to the lift car 10, is attached to, or formed integrally with, the

piston 40. It will be noted that, unlike the piston rod of a conventional hydraulic ram, piston cylinder 38 is in communication with cylinder 36 and filled with oil. This is believed to have an advantage in the reduction of the buckling loads to which the unit 31 is subjected.

The outer lower end of piston cylinder 38 carries a further piston or annular seal 44 which slides over, but seals against, the outer surface of the drive cylinder 36. The piston cylinder is further supported by upper seal 46, the seal 46 being fixed to outer cylinder 32 but forming a sliding seal against the outer surface of piston cylinder 38.

To drive the lift car 10 in an upwards direction, hydraulic fluid is fed under pressure, through port 48, in base member 34. Port 48 communicates with the interior of drive cylinder 36 and, in turn, with the interior of piston cylinder 38. Thus the incoming fluid acts against piston 40 and causes the piston cylinder 38 to telescope upwardly over the drive cylinder 36. When the lift car is to move in a downwards direction, the port 48 is placed in communication with a low pressure reservoir and the fluid within the interior of the cylinders 36 and 38 pumped or allowed to bleed there-from.

It will be appreciated that an annular chamber 50 is defined between the inner surface of the outer body 32 and the outer surfaces of the drive and piston cylinders 36 and 38 respectively. This chamber is used to provide the supporting force discussed above. Whilst some form of mechanical contrivance could be fitted within the chamber, for example a coil spring acting between the base 34 and the seal 44, the chamber 50 is preferably charged with compressed gas so that a gas strut is formed about the hydraulic drive.

As can be seen, the seal 44 not only provides a sliding seal between the cylinder 38 and the cylinder 36, but also extends across annulus 50 to provide a sliding seal against the inner surface of cylindrical body 32. Axial ports 52 are provided in the seal 44 to allow the sections of the chamber 50, above and below the seal 44, to communicate with one another.

The chamber 50 is charged with compressed gas through port 53 in the base 34. Once the chamber 50 is charged with the required amount of gas, the port 53 may be sealed off. However, to provide a greater volume of available gas, and to reduce the difference in pressure between when the piston is expanded and when the piston is retracted, it is preferable to provide an external gas chamber 54 which is placed in communication with the port 53.

The configuration of the components ensures that the compressed gas within chamber 50 provides an upward component of force on the seal 44 and thus counterbalance, at least to some extent, the downward component of force imposed by the lift car 10 and any load carried thereby.

Preferably chamber 50 is charged with gaseous nitrogen as nitrogen is substantially inert. It will be appreciated, however, that other gases could be used without departing from the scope of the invention.

To configure a drive system as described above, the empty load of the lift car 10 is calculated and the number of counterbalances, the geometry thereof, and the gas pressures therein, determined so as to ensure the lift car 10 always imposes a small net downward force. This ensures the lift car is able to descend under manual lowering.

By way of example only, a lift and lift drive system could have the following nominal configuration:

Weight of lift car	800kg
Rated load	630kg
Required counter balance (90% of lift car)	720kg
Inside diameter of cylinder 32	114mm
Outer diameter of cylinder 38	68mm

Hydraulic working pressure	115 bar
Gas pressure in chamber 50	103 bar
Hydraulic tank capacity	40 litres

The above specification enables a lift of the cited weight to be operated at a nominal speed of 0.63m/s using a motor rated at 7.5KW.

The lift drive system as above described is believed to have the following advantages:

1) Because a substantial part of the operating mass of the lift is counterbalanced, effective lift operation can be achieved using a relatively small hydraulic package.

2) The system requires a relatively small volume of hydraulic oil to operate.

3) Because of the low loading imposed on the hydraulic drive, heat and noise generation is low.

4) The hollow piston rod in communication with the interior of the cylinder reduces buckling for a given load.

Many variations to the system above described will present themselves to those skilled in the art. For example, as stated above, the invention may be applied to lifting or support systems other than lifts or elevators and may be incorporated in other lifting systems.

Further, whilst in the embodiment described in Figures 4 and 5 incorporates a configuration in which the gas chamber is provided in an annulus about the hydraulic drive chamber, the chambers could, conceivably, be reversed.

It will thus be appreciated that the invention, at least in the case of the working embodiment herein described, provides a novel and effective means of reducing the power requirement of an hydraulic lift which requires no specialist fitting requirements and is independent of the lift drive system.

Claims

1) A method of reducing the power requirement of a lift having a load carrier and an hydraulic drive system, including hydraulic fluid, to displace said load carrier toward and away from a base,
said method comprising positioning support means between said base and said load carrier, said support means being configured not to receive said hydraulic fluid and being operable to at least partly support said load carrier.

2) A method of reducing the power requirement of a lift having a load carrier and an hydraulic drive system to displace said load carrier toward and away from a base,
said method comprising positioning at least one gas strut so as to operate with the displacement of said load carrier, said gas strut being constructed and arranged to at least partly support said load carrier.

3) A method of reducing the power requirement of a lift having a load carrier and an hydraulic drive system to displace said load carrier toward and away from a base,
said method comprising positioning at least one spring accumulator so as to operate with the displacement of said load carrier, said spring accumulator being constructed and arranged to at least partly support said load carrier.

4) A method as claimed in claim 2 or claim 3 comprising positioning said gas strut or said spring accumulator between said load carrier and said base.

5) A method as claimed in any one of claims 2 to 5 wherein each of said hydraulic drive system, said gas strut and said spring accumulator has an operating stroke, said method comprising positioning said gas strut or said spring accumulator so that the stroke thereof is substantially parallel to the stroke of said hydraulic drive unit.

6) A method as claimed in claim 5 further including constructing and arranging said gas strut or spring accumulator so that the stroke thereof is co-linear with the stroke of said hydraulic drive unit.

7) A lift having a load carrier and an hydraulic drive system, including hydraulic fluid, to displace said load carrier toward and away from a base,
said lift being characterised in that support means are positioned between said base and said load carrier, said support means being configured not to receive said hydraulic fluid and being operable to at least partly support said load carrier.

8) A lift having a load carrier and an hydraulic drive system to displace said load carrier toward and away from a base,
said lift being characterised in that at least one gas strut is provided so as to operate with the displacement of said load carrier, said gas strut being constructed and arranged to at least partly support said load carrier.

9) A lift having a load carrier and an hydraulic drive system to displace said load carrier toward and away from a base,
said lift being characterised in that at least one spring accumulator is provided so as to operate with the displacement of said load carrier, said spring accumulator being constructed and arranged to at least partly support said load carrier.

10) A lift as claimed in claim 8 or claim 9 wherein said at least one gas strut or said at least one spring accumulator is positioned between said load carrier and said base.

11) A lift as claimed in any one of claims 8 to 10 wherein each of said hydraulic drive system, said gas strut and said spring accumulator has an operating stroke, said gas strut or said spring accumulator being positioned so that the stroke thereof is substantially parallel to the stroke of said hydraulic drive unit.

12) A lift as claimed in claim 11 wherein the stroke of said gas strut or spring accumulator is co-linear with the stroke of said hydraulic drive unit.

13) A lift having a load carrier characterised in that a stroke-based support device (as herein defined) is provided to at least partly support the weight of said load carrier.

14) A lift having a load carrier and at least one hydraulic ram having a first operating axis, said ram being operable to displace said load carrier in upwards and downwards directions, said lift being characterised in that it further includes a stroke-based support device (as herein defined) having a second operating axis, said stroke based support device being constructed and arranged to at least partly support the weight of said load carrier, wherein said second operating axis is substantially parallel to said first operating axis.

15) A lift as claimed in claim 14 wherein said second operating axis is substantially co-linear with said first operating axis.

16) Operating means for displacing a load in a linear direction, said operating means including a piston displaceable from a cylinder, along a substantially linear drive axis, by the entry and egress respectively of pressurised hydraulic fluid into and from said cylinder; and support means constructed and arranged to at least partly support the weight of a load applied to said piston in a direction which biases said piston into said cylinder.

17) Operating means as claimed in claim 16 including a housing, said cylinder and support means being located within said housing.

18) Operating means as claimed in claim 16 or claim 17 wherein said support means has an operating stroke in which a supporting force is applied along a substantially linear support axis, said support axis being substantially parallel to said drive axis.

19) Operating means as claimed in claim 18 wherein said support means is arranged about said hydraulic cylinder and wherein said support axis is substantially co-linear with said drive axis.

20) Operating means as claimed in any one of claims 16 to 19 wherein said resistance means includes a further chamber located about the exterior of said hydraulic cylinder; a pressurised gas within said further chamber; and a second piston displaceable with the aforementioned piston, said second piston being displaceable within said further chamber whilst said aforementioned piston is displaceable within said hydraulic cylinder.

21) Operating means as claimed in any one of claims 16 to 20 wherein said support means is further constructed and arranged to, in use, assist in driving said piston from said cylinder.

22) An hydraulic or pneumatic drive ram having a cylinder; a piston rod extendible from, and retractable into, said cylinder; and a working fluid, said drive ram being characterized in that said piston rod has an interior chamber in communication with said cylinder, said chamber, in use, receiving said working fluid.

23) Any novel and useful combination of elements or integers disclosed herein.

ABSTRACT

A hydraulically driven elevator or lift is provided with support means to at least partly counterbalance the load imposed by the load carrier or lift car. Operation of the support means does not involve any interference with the working fluid of the hydraulic drive system

(use Figure 3)

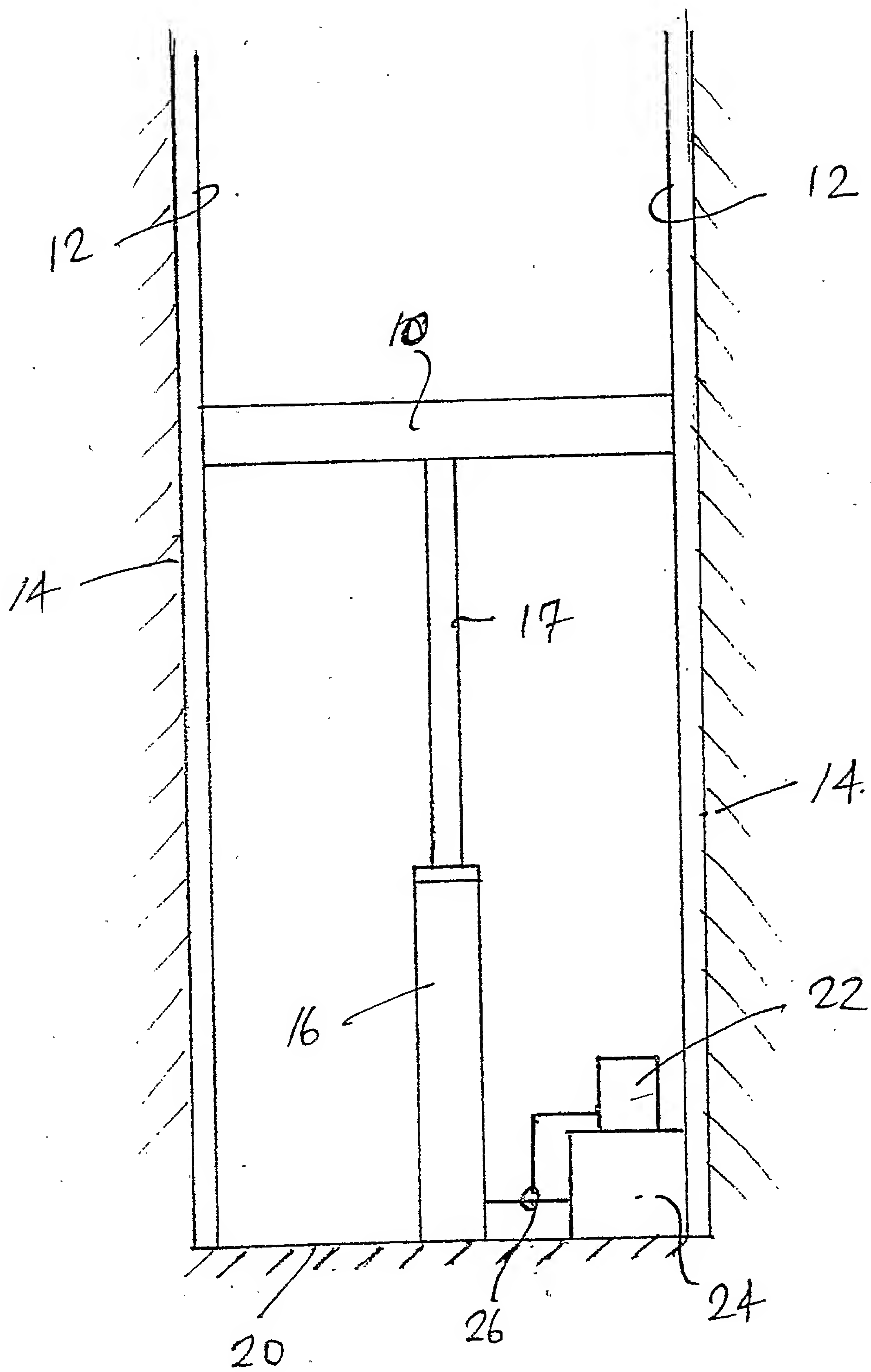

FIGURE 1

PRIOR ART

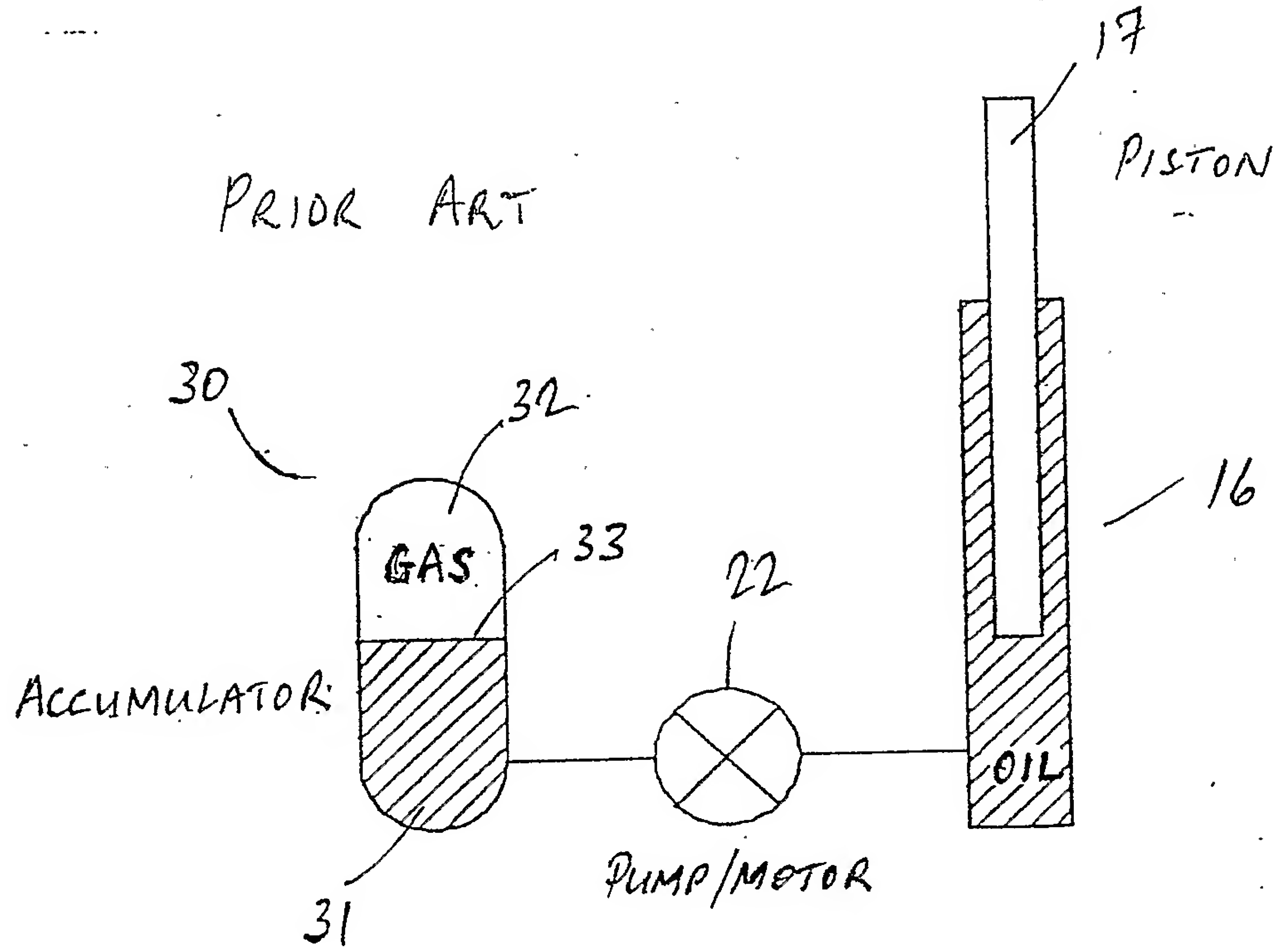

FIGURE 2

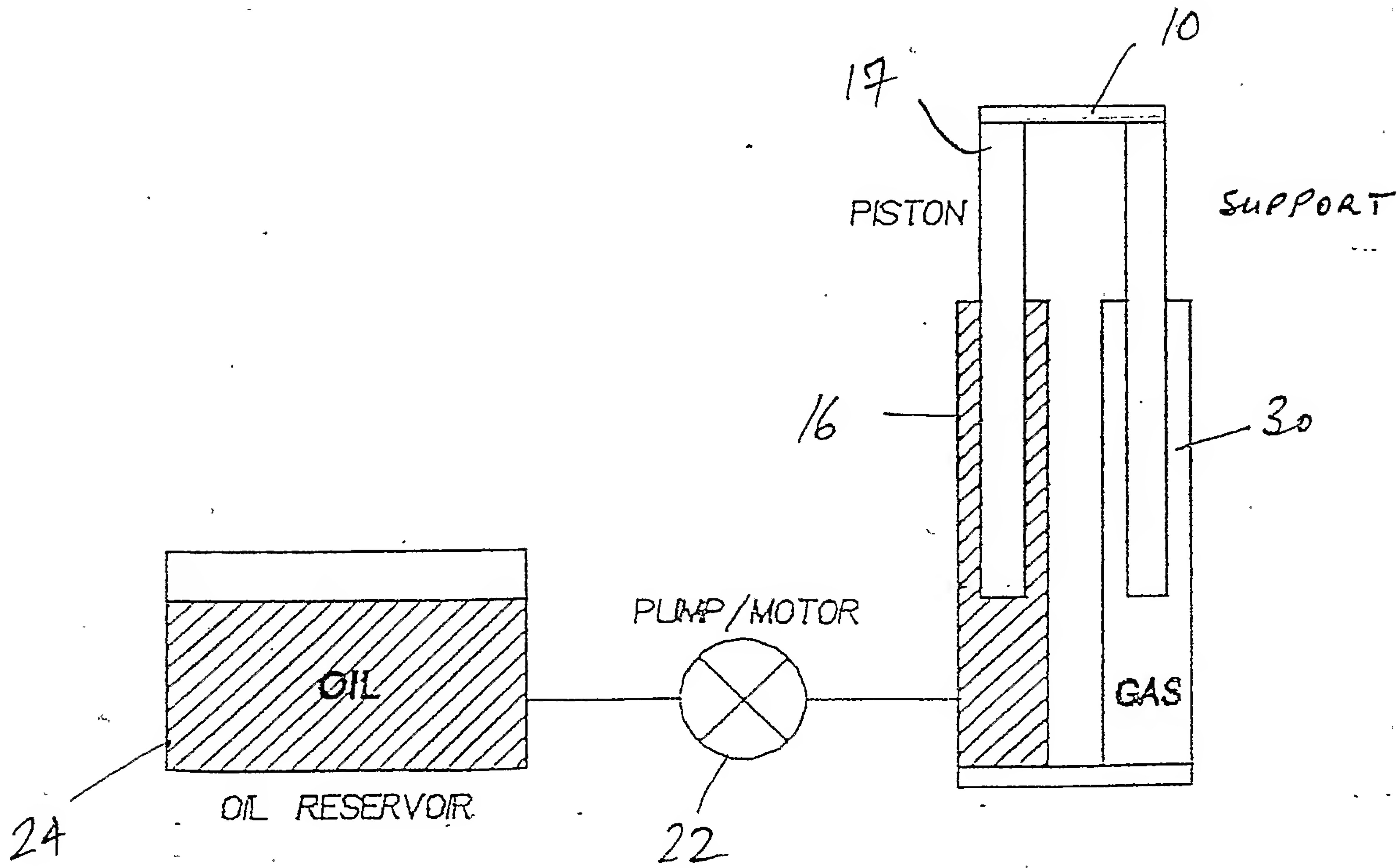

FIGURE 3

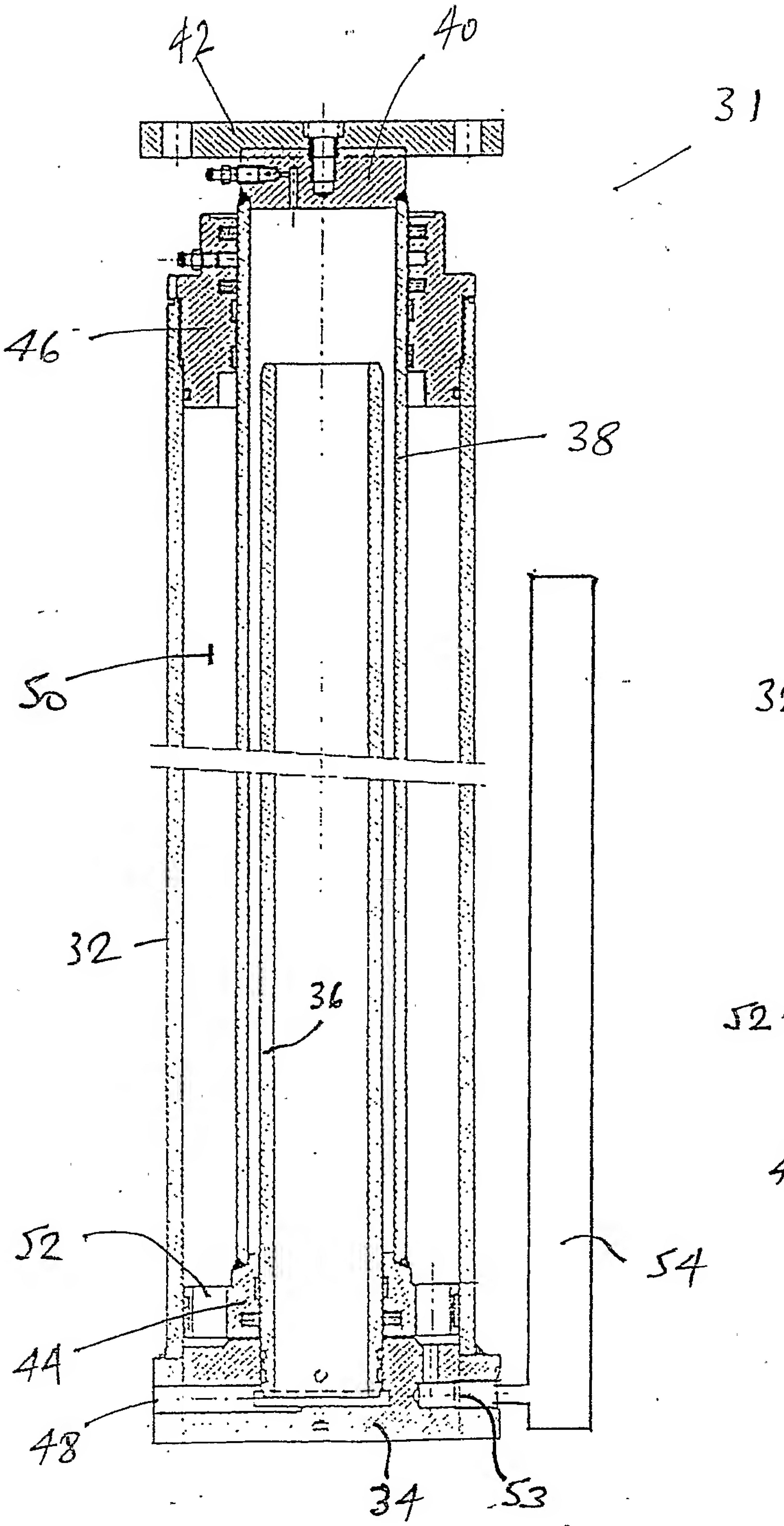

FIGURE 4

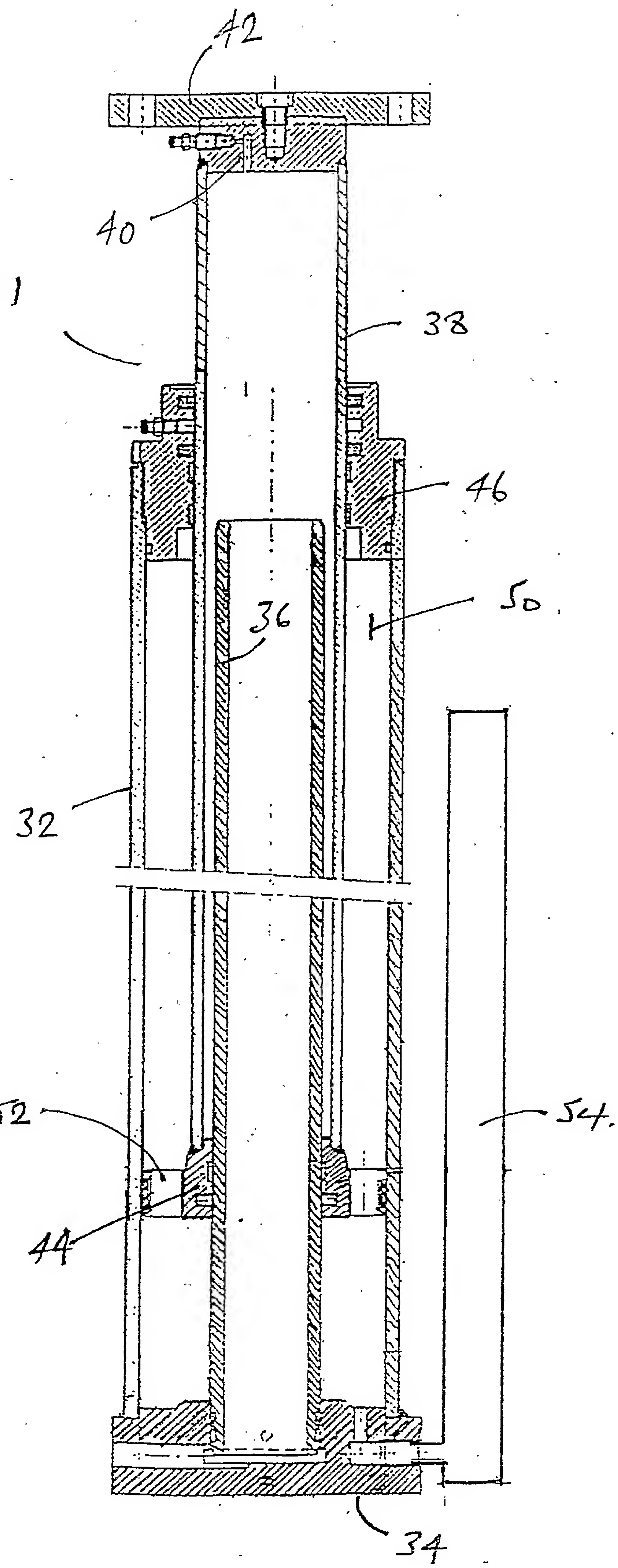

FIGURE 5